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ABSTRACT

This paper, in reviewing four different studies, discusses the influence of some basic parameters or aspects of a sign on the accuracy of perceiving that sign. This information can aid the teaching of signs to the mentally retarded, the autistic, the cerebral palsied, and the hearing adult. A series of studies was conducted in which the aim was to control (eliminate), as directly as possible, the given parameter on which interest was focused. In the case of location in reference to the body, the face, body, arms, and legs were eliminated from the picture. Movement was controlled by holding the hands still. Handshape was controlled by first using only one basic handshape and then by using rather formless mittens. Findings indicate that the method by which data about sign parameters are collected very markedly affects results. In terms of the various studies, conflicting results include: (1) parameter effects are sign specific, (2) movement is the most important parameter, and (3) movement is the parameter least influential on recall. (JK)

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Information About Signs as a Function of Experimental Method

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Part I

For some time now, King Jordan and I have been trying to obtain information about the influence of some basic parameters or aspects of a sign on the accuracy of perceiving that sign. I want this information primarily becasue I think it can help teachers better teach signs to the mentally retarded, the autistic, and the cerebral palsied. King Jordan, on the other hand, is more interested in the teaching of hearing adults. In any event, our basic approach is to control as directly as we can, the parameter in which we are interested. Control in our research means to eliminate or do away with the parameter. In the case of location in reference to the body, we simply eliminate the face, body, arms, and legs from the picture. Movement is controlled by holding the hands perfectly still. And handshape was first controlled by using only one basic handshape and, now, by using rather formless mittens. I would like to make a preliminary report on the effects of these methods of experimental control on the accuracy of sign perception.

Two weeks from now I will also describe three studies by other investigators that attempt to account for or control these parameters in quite different ways. The methods employed are (1) inferring parameter effects from an intuitive analysis of mistaken English glosses, (2) timing the imitations and guesses

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of the sign from a segmentally incremented time presentation of its execution, and (3) comparing errors in the recall of specially assembled lists of signs, each which shares a single fixed parameter as against lists which do not have fixed parameters. The procedures employed yield quite different information. As I will hope to show you, the common basis for all four studies is an analysis of error. For this kind of analysis, certain levels of difficulty are more useful than others.

Our first research effort was a pilot study of our technique. We videotaped a congenitally deaf signer, born of deaf parents, who signed thirty signs from a list of frequently used signs compiled by Lloyd and Fristoe. In random sequence, each sign was shown in (a) a fixed position, (b) without background, and (c) with a closed "B" handshape.

We uncovered two major problems with our pilot study presentation. First, while a center, fixed position seemed to provide a "reasonable" picture of the sign for those 80% of the signs that did not change significantly in location or hand orientation, it clearly did not do so for the remaining 20% that did. After some consultation, we changed our method of presentation for the second group of signs. We chose to fix both the initial and final position of each sign and measure these separately. Second, we were dissatisfied with the closed "B" handshape as our neutral handshape, so we enclosed our signer's hands in rather shapeless mittens. Our second videotape, therefore, is most similar to the first version in the location controlled mode, somewhat less similar in the movement controlled mode, and least similar in the handshape mode.

On all sessions, subjects are permitted seven seconds to write down the English gloss of the presented sign. Fifty different Gallaudet College students who judged themselves to be reasonably fluent in signs served as subjects for each version. They are described in Table 1. Although ten times as many Gallaudet students have two deaf parents as the generality of deaf students (30 percent as compared with 3 percent), the group still reports using signs for the first time, on the average, sometime during the first years of school age. Contrary to popular belief, deaf students born of two deaf parents report that, on the average, they begin to use signs after they come to school (Mean = 6.47; S.D. = 5.88). As a group, however, they still begin using signs about five years earlier than students with only hearing parents (Mean = 11.55; S.D. = 6.29). Moreover, as can be seen in Table 2, they see themselves as somewhat better signers. Since the range of signing ability of these subjects is extremely restricted in range, the product movement correlation between self-evaluation of sign reading ability and number of correct recognitions is only .25. In the pilot study or first version, the correlation was .31.

Table 1

Background characteristics of fifty (50) different subjects on each test version

VARIABLE	MEAN		S. D.	
	Version One	Version Two	Version One	Version Two
Age	21.76	22.49	2.15	3.56
Age of First Signing	7.39	5.22	10.11	6.59
Self Evaluation of Sign Competence	2.62*	.49	2.44**	.67
	First Version		Second Version	
Number of Deaf Parents	Two = 15 One = 1 None = 34		14 0 36	
Sex Males Females Unidentified	17 32 1		23 27 0	
Schooling Residential Day School Day Class Regular Class	27 6 2 15		25 8 6 11	

*3 = excellent
2 = average
1 = poor

**3 = very good
2 = good
1 = average

Table 2

Self-evaluations of sign reading ability
expressed by number of hearing impaired parents

		Number of hearing impaired parents	
		2	0
Sign Reading Ability	Very Good	10	17
	Good	4	14
	Average	2	13

Table 3 shows the means and standard deviations of percent right for each condition on both the first and second versions of the test.

Table 3

Means and SD's of percent correct for three conditions
on the first and second versions of the
Sign Recognition Test
(N=50 for each version)

	No Location		No Movement		No Handshape	
	Version		Version		Version	
	One	Two	One	Two	One	Two
Mean	57.1	60.1	54.4	51.3	50.3	49.7
S.D.	8.2	7.2	9.0	7.0	7.0	9.6

The subjects, Gallaudet College students, found the task difficult. Mean scores ranged from about 50 to 60 percent correct. The same order of difficulty held for both test versions. Location seems to be a little less important for accuracy of recognition. I don't see much practical difference, however. I will return to this kind of analysis later in the paper.

Now to analyze our changes in control of motion --

For controlling motion, you will recall that we subjectively divided the signs into two kinds: (a) those that did not move markedly from location to location and (b) those that did involve a significant change in location or hand orientation. Table 4 shows that the students did much better on the freeze of the first type of movement, about 64% on the average. The second type was extremely difficult to read, with a freeze in the final position being virtually impossible to read accurately.

Table 4

Means and SD's of percent correct signs "fixed" in the central, initial and final positions

	Number of Signs	Percentage Correct	
		Mean	S.D.
Center	24	61.0	32.4
Initial	6*	23.0	23.4
Final	6*	2.4	5.2

* These are the same signs

Since we are primarily interested in how well signs can be read given certain restrictions, there are certain statistical characteristics that we should examine. First, it would greatly

suit our purpose if variations in difficulty caused by our control greatly exceed variability due to individual differences in sign reading ability. As Table 5 shows, this is gratifyingly and happily the case. Controlling sign parameters greatly affects accuracy of recognition. In other words, when a parameter for some signs is omitted, the signs are still easy to recognize. With other signs, it becomes very difficult to read the sign accurately.

Table 5

Standard Deviations of percent correct readings for both versions under all three conditions

Variations (SD) attributed to	No Location		No Movement		No Handshape	
	Version		Version		Version	
	One	Two	One	Two	One	Two
Differences between individuals	8.2	7.2	9.0	7.0	7.0	9.6
Differences between signs	38.5	38.0	34.2	35.2	35.2	35.1

Second, we would like our sign difficulties to be stable from one group of individuals to another. To check this, we simply obtained the product movement correlation between item or sign difficulties on both versions. These are shown in Table 6.

Table 6

Product moment correlation coefficients between item (sign) difficulties on the two test versions for three conditions

Condition	r
No Location	.90
No Movement	.79
No Handshape	.56

Clearly, changing from the "B" position to a mitten caused item or sign difficulties to shift considerably from version to version. However, item difficulties in the "no location" and "no movement" conditions show very high correlations. The magnitude of the relationships appear to reflect the amount of change we made in our control methods. In summary, most of the variation in these performances are stable and can be attributed to the conditions we have imposed on these signs. We really have something to work with when we work with special learners.

Finally, we would like to know if comparable results would be obtained if another group of signs were involved. Since we were collecting data on 330 signs, it was a small matter to compare accuracy of recognition on a second set of 30 signs with our first set of 30 signs on the second version data.

Table 7

Means and standard deviations of percent correct readings for two different samples of signs*

	No Location		No Movement		No Handshape	
	Sign Sample One	Two	Sign Sample One	Two	Sign Sample One	Two
Mean	60.1	43.4	51.3	55.2	49.7	72.8
S.D. (of signs)	38.0	31.8	35.2	32.0	35.1	32.2

*30 signs in each sample of signs.
50 subjects for each sign sample.

As can be seen in Table 7, the "no handshape" condition previously found most difficult is now the easiest. Exactly the opposite holds true for the "no location" condition. If we look at comparable data for three different treatments of movement found in Table 8, fixation in the center position is about the same and, again, is very much easier than the initial and final fixations. However, these last two conditions are reversed for this second set of signs with the final fixation actually being easier than the initial position. In all but one feature - the center position fixation, this sample of signs yields different findings than the previous one.

Table 8

Means and S.D.'s of percent signs fixed in the central, initial and final positions

	Center		Initial		Final	
	Sign Sample One (N=24)	Sign Sample Two (N=25)	Sign Sample One (N=6)	Sign Sample Two (N=5)	Sign Sample One (N=6)	Sign Sample Two (N=5)
Mean	61.0	61.6	23.0	11.6	2.4	16.2
S.D. (of item difficulties)	32.4	31.4	23.4	17.7	5.2	14.7

What can we make of all this? Effects of parameters controlled by our methods are very large, very sign specific, and very stable. Variation due to these parameters is very much greater than that found between fluent sign readers. The only clear systematic effect is that fixing or freezing signs that move from one significant location or hand orientation to another are much more difficult to read than those which do not. Results vary from one sample of signs to another. How one controls these parameters and how one samples signs from the population of signs is clearly essential for accurate information in this field. I, for one, will not be content until we have collected data for all 330 of our signs.

Part II

There are three other studies that I have found that deal with the significance or importance of different parameters of sign. Two of these deal with perception. The third is concerned with short-term memory, although by the nature of its procedures, translation is involved as well. As I noted last week, they accounted for sign parameters in quite different ways than I described in Part I of

this report.

The first study by Crittenden appeared in Sign Language Studies (Crittenden, 1974). He reported on two very similar experiments, the second being a reduced version of the first; i.e., he used a smaller number of signs, 25 rather than 77. The signs were randomly chosen from the NAD's ABC sign book. The only description given of the subjects were that they had completed an introductory course in "sign language". There were 30 subjects in the first experiment and 29 in the second. Signs were shown singly on a 17" TV monitor and the subjects were allowed 10 seconds to write down the English version of what they had just seen. When the English gloss was in error, Crittenden noted what parameter or parameters inherent in the written gloss were different from the parameters of the stimulus sign. He justifies this procedure because he is the son of deaf parents and is, therefore, a native user of sign language. In those cases where the English gloss was not inherently similar on any of the three features, he reasoned that they really did not know the sign and such responses were not analyzed.

Crittenden hypothesized the "errors" would order or rank as follows (using my terminology rather than his):

Table 9

Rank and percentage of errors by sign parameter

Predicted rank of different parameters	Experiment 1	Experiment 2	Rank for mean % of both experiments
1) movement	34.7	33	1 (33.85)%
2) handshape	25.9	25.3	2 (25.6)
3) movement/handshape	20.1	8.0	3 (14.05)
4) movement/location	7.5	8.0	5.5(17.75)
5) handshape/location	6.8	14.6	4 (10.7)
6) location	4.9	10.6	5.5(17.75)

Of the "mistakes" made by these novices, about a third dealt with movement, a fourth with handshape, and the remaining four possibilities cluster loosely about the ten percent mark. One problem with this research report is that a reader can only guess at the level of performance of these novices. While a total number of errors is given for each experiment, the number of signs that were judged wrong on all three parameters is not given. If we assume that these were zero or very few, then we can estimate the difficulty of the tests by dividing the number of reported errors by the total number of items. This yields average levels of difficulty of 82% for experiment one and 90% for experiment two. If this estimate is accurate, then the subjects found this an easy task and made relatively few errors. Experience suggests that errors on easy tasks, i.e., at the 90th percentile or better are often caused by lapses of attention and idiosyncratic features of stimulus selection.

I believe that the consequences of the experimental procedures used in this study are far greater than those that the experimenter himself recognized. Although he was fully aware that the subjects were novices and thought that there might be a "subtle" bias to his judgements, I regard the experimenter bias in this study as very, very serious indeed. It is simply not an acceptable procedure. Even more serious is my concern about the validity and meaning of inferences drawn from an incorrect English gloss especially when the sign for that gloss is different on two of three parameters.

A working paper by Grosjean, Feuler, and Lane employs a much more novel procedure which requires both a comprehensive description and a demonstration. Essentially, a sign is segmented into 24 parts,

each of which includes that which has transpired previously. In every case the signer's hands started the sign at waist level from a table top. The first segment presented lasts for 28 milli-seconds (msec). The second presentation includes the first 28 msec. plus 26 additional msec. of the sign or 54 msec. The presented sign increments at 26 msec. through the 20th presentation, always including that which came first. The last four presentations, numbers 21 through 24, increment at 55 msec. a presentation. The entire sign presentation took 744 msec. There was a four second interval between presentations. The interest interval was 15 seconds.

Thirty-seven signs selected: 27 one-handed and 10 two-handed. They chose at least two signs at eight different locations. The subject was requested to do three things after each presentation. First, copy what he saw. Second, guess the sign by signing it. Third, give a confidence judgement from 1 to 5 about that guess. For each subject and each sign, a judge determined the point when that copy or guess began to coincide with the presented sign perfectly and permanently. (The subject maintained the same response until the end of the set.)

Scores were the value of presentation time divided by mean identification time and multiplied by 100; i.e., $\frac{Xi}{X}(100)$, yielding a normalized measure of movement of sign. A fourth parameter, orientation of the palm was included in their study.

The subjects were five fluent congenitally deaf signers, born of deaf parents.

Their results were easily stated "... as the presentation time of a sign increases, S's will first propose guesses in which the orientation, location, and handshape of the target sign are most

often correct but in which the movement is still wrong, and then, when enough movement information is perceived, the guess will be corrected to take into account this last parameter and ipso facto the sign will be identified." In other words, the movement information is the last to be perceived.

My problem with this procedure is simply stated. Presentation time in this experiment begins at waist level, which is a most infrequent starting point for the execution of a sign under any real circumstances. Of even more moment, I believe that sign movement is usually considered to begin at a location or position from which percepturally meaningful movement begins. Put differently, the hands are transported to a given location before movement is executed. If this is a correct interpretation, then movement should be timed from that given location, rather than over the long lead time required to get there from the waist. It seems to me that their data suggests that while the individual is moving to the "starting position", he begins to form the appropriate handshape, assumes the correct palm orientation, and arrives at the correct location before beginning to execute the proper movement.

The last study I will discuss is by Klima and Bellugi (1979). It deals with three parameters of sign, location, movement, and handshape (although the authors use different terms for these parameters) but from a somewhat different perspective, that of short term memory. In one of a series of experiments dealing with memory, the authors selected 90 signs for this memory experiment. The signs were judged to be commonly known, had fairly direct translations into English words, and were not inordinately long or compound signs. Deaf researchers intuitively assigned the signs to 18 lists of five signs each. Six lists each showed a different movement in common,

six lists each had a common location, and six lists each had a common handshape. Essentially, a parameter is controlled by being held constant in a set, while the other two parameters are permitted to vary.

The same 90 items were used to construct 18 random lists of five signs each. All three parameters in these lists were allowed to vary freely. The basic experimental design is the comparison of recall of the subset of items on the random lists against the recall of these same items on the single controlled parameter lists. Since three parameters are involved, three comparisons were to be made; i.e., location against random, movement against random, and handshape against random.

Instructions were given on the tape in signs by a native signer and by printed English. Subjects were required to write the English gloss of a sign. Subjects were first required to name the signs so that the experimenters could determine that the English glosses were the same as those reported on the memory tasks. Structured and random lists alternated. Following the presentation, subjects recalled the signs and wrote them in the test booklets. Subjects were 24 prelingually deaf college students, 11 from California State University at Northridge and 13 from Gallaudet College. Of these, 17 had deaf parents and the others were fluent users of ASL. Now to results--the task was very easy for these subjects. It turned out that six subjects had a memory span greater than four and recalled nearly every list perfectly. As noted earlier and as seen in Figure 4.13, when compared to the recall of the same items in random sets, similar location sets <u>decreased</u> recall by 14% or over half an item. A similar handshape <u>increased</u> recall by 9% or about a third of a

sign. And similarity in movement does not seem to affect recall in any significant way over that found in random sets.

On this very easy task, therefore, we have the very odd phenomenon that sometimes a fixed parameter facilitated recall, sometimes interferred with recall, or sometimes had no effect on recall. How can this be? Why did the parameters have these varying effects? Klima and Bellugi determined from judgements of hearing persons that movement sets appeared to be more similar than the other sets. They reasoned, therefore, that similarity may be just less salient with movement and therefore has less effect on recall. However, when handshape is held constant, it might be stored as a property of the list and used at recall to make better use of the sensory information remaining in short term storage; i.e., perhaps a strategy for choosing alternatives at time of recall. Finally, whatever produces interference in short term memory in spoken language might cause the similarity of location of the sign to produce a decrement in short term memory for sign lists.

I find these unconvincing explanations of contradicting or differing results. For example, why shouldn't every parameter be stored as a property of a list and facilitate recall of the items? If you will remember, we found substantial variation in parameter effects which appeared to be attributable to the sample of signs investigated. I suspect that these obtained differences may well be due to subject and/or sign sampling fluctuation.

In summary, the method by which data about sign parameters are collected very markedly affects results. Our methodology reveals parameter effects to be sign specific. Two other studies of the perception of signs indicate that movement is the most important parameter. A third study found movement least influential on recall.

For methodological reasons, I have questioned the validity of the conclusions of all three studies. You will have to be the judge of the adequacy of my criticisms.

In the meantime, what might be done to obtain clear and unequivocal information in this area? As you know, we plan to test more than 550 subjects on 330 signs. I firmly believe that a marked increase in the size and quality of subject and sign samples is absolutely essential for hypothesis testing in this area. Finally, I have specific, if unsolicited, suggestions to make about the experimental procedures employed in two of the studies described earlier. I would suggest a careful redefinition of the starting point of time of duration in the Grosjean, et. al. techniques. I would also like to see the number of signs in the Klima and Bellugi technique increased from five to six and preferably seven. Increased difficulty should make this procedure very much more powerful.

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